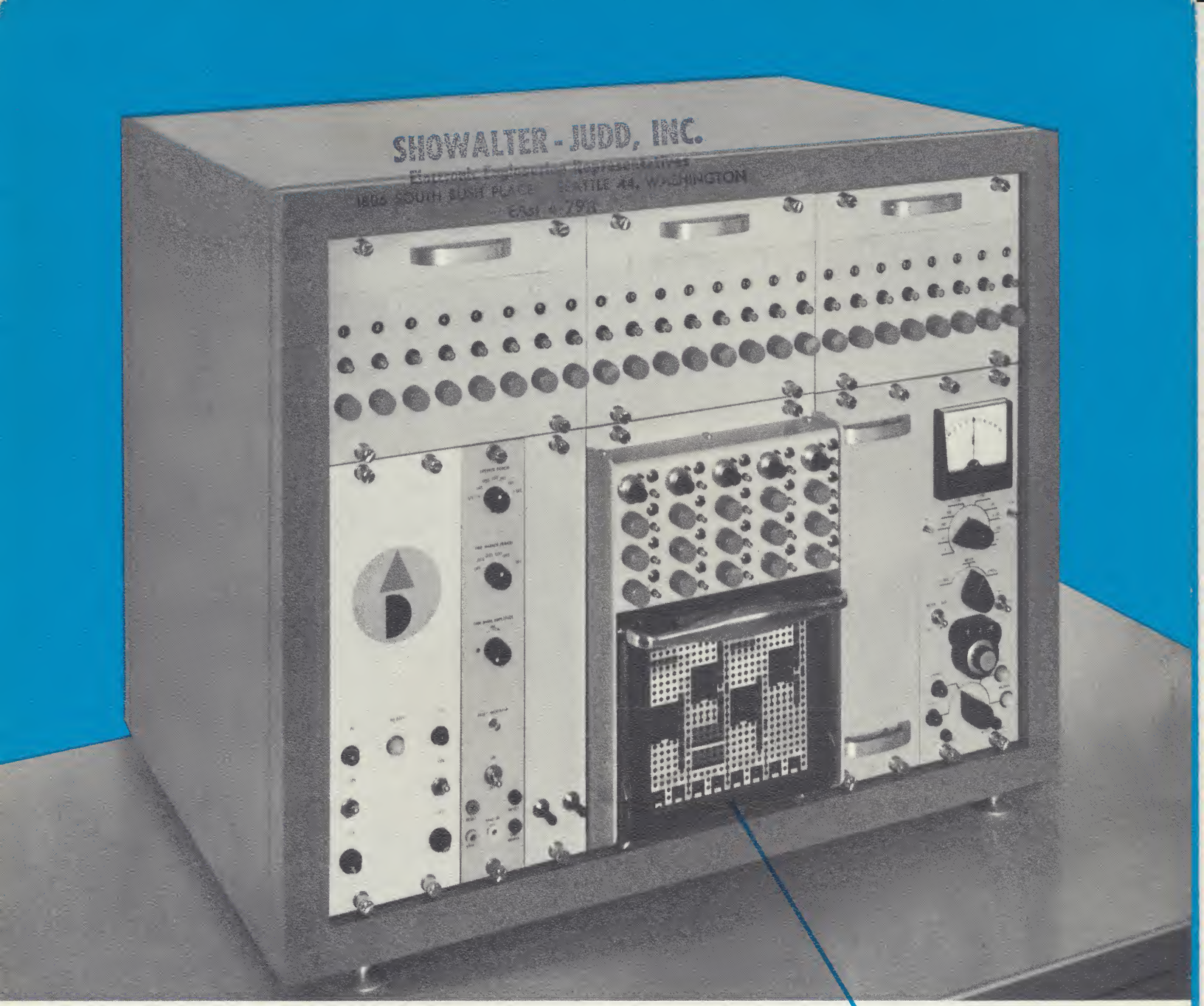
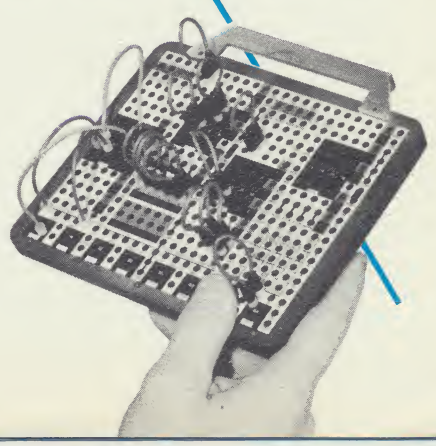


AD

AD-2-24PB ANALOG COMPUTER

WITH REMOVABLE PATCHBOARD



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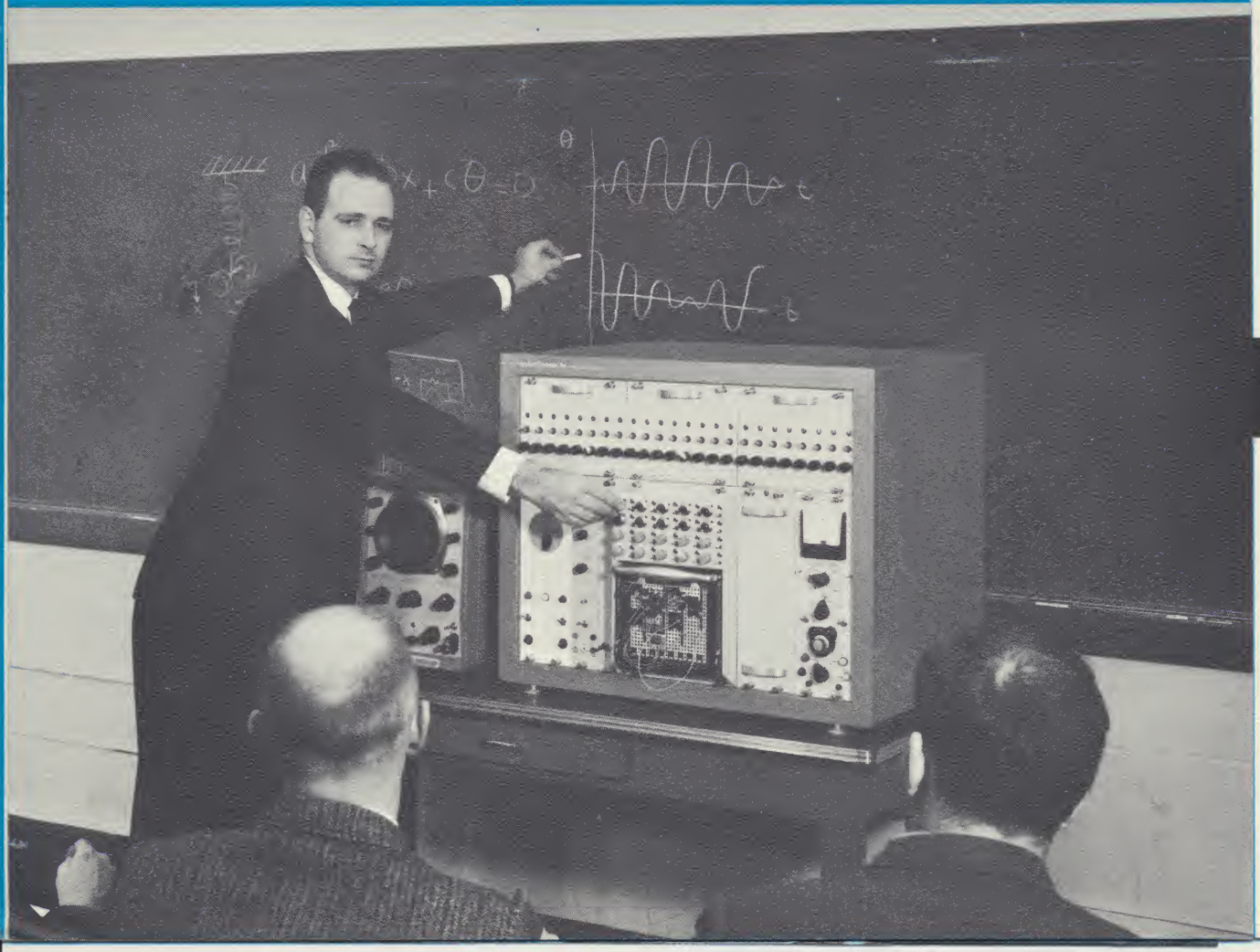
COMPONENTS INSIDE

A VALUABLE TOOL

. . . for solving really significant problems in engineering, scientific research and applied mathematics. An important laboratory instrument for such applications as data processing, filtering, on line control and transducer compensation.

This compact, economical unit includes large computer features such as: ■ Removable Patchboard ■ Built-in high precision input and feedback impedances ■ Highest accuracy fixed non-linear elements ■ Variable Diode Function Generators with variable breakpoints and fine and coarse adjustments ■ "Potentiometer Set" and "Balance Check" Mode ■ Patchboard terminated interconnects for slaving and input-output equipment ■ All electronic repetitive operation for highest reliability and timing accuracy ■ Individual programming of each integrator in fast and slow speed real time as well as high speed repetitive operation.



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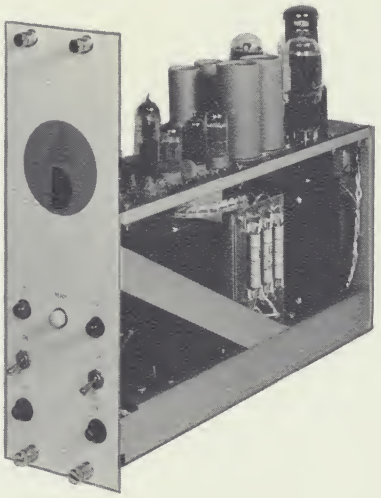
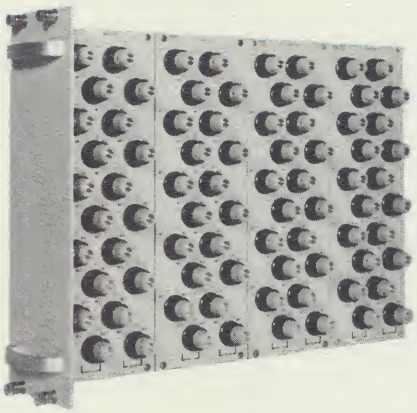
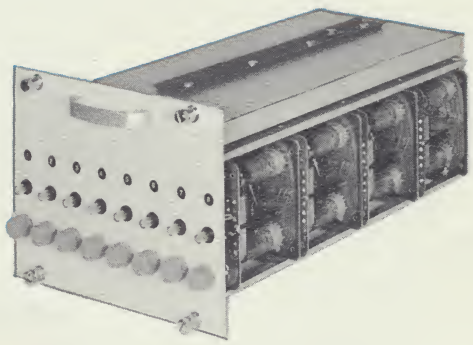


POWER SUPPLY
Model E8.106 included in Basic Computer provides all power voltages required by the system. Front panel controls include Master AC power switch and DC OFF-ON switch with color coded illuminated indicators. A READY light signals end of time delay interval for application of power to vacuum tube plates.

HIGH SPEED REPETITIVE OPERATION CONTROL UNIT
Model E6.180.1 provides drive signals for Model D4.182 Dual Repetitive Reset Units. Controls include Rep-Op activation switch, Compute Period Selector, and an interval selector and amplitude adjustment for oscilloscope Z axis modulation with time marking signals. Front panel termination of all signals and trigger input for external start of cycle.

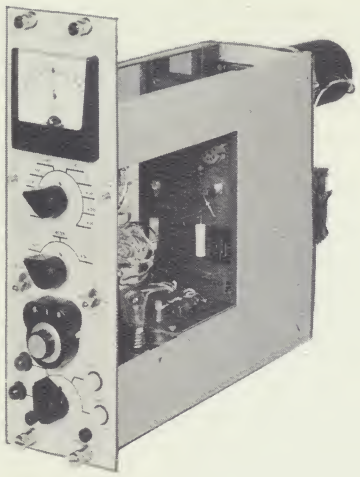


VARIABLE DIODE FUNCTION GENERATOR
slide out drawer Model D9.171.1 provides mounting for up to 4 Model E3.171.1 Variable Diode Function Generators. Each of these 10 segment units allows completely arbitrary location of breakpoints between —100 and +100 volts. Slopes adjust between ±2 volts per volt. A six position coarse-adjustment switch and a one turn vernier potentiometer are provided for each breakpoint and slope. Indicator knobs conveniently show location of each adjustment.



8 AMPLIFIER MODULES
on slide out rails are included with networks in Amplifier Expansion Modules. One Model F12.13 provides complete expansion of 4 integrator-summers (amplifiers 1 through 4) and 4 summers (amplifiers 5 through 8). A second F12.13 similarly adds amplifiers 9 through 16. One Model F12.14 adds 8 summer-inverters (amplifiers 17 through 24). Modules each include four Model D1.111.2 Dual Amplifiers and wired connectors for adding four Model D1.122.1 Dual Stabilizers. Individual Readout Pushbuttons, Overload/Balance Check indicators, and Balance Adjust Potentiometers are conveniently located on the front panel.

COMPONENTS INSIDE



CONTROL UNIT

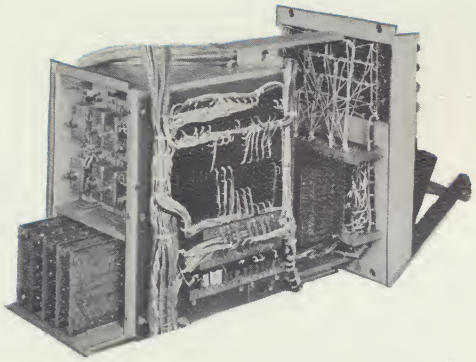
Model E6.102.1 supplied with Basic Computer includes Mode Control Switch with color coded mode indicator lights, voltmeter with meter range and function switch, and null potentiometer with Digidial and polarity switch. Switch selection allows direct monitoring of all power supply voltages. The null circuit range switch provides increased accuracy for setting coefficients and measuring voltages below 0.1 of full scale. ±100 volt reference supplies and reference overload indicators are located in the Control Unit.

COMPARATOR SWITCH MODULE

Model E4.2 mounts adjacent to patchbay assembly. Unit includes two Reference Voltage Selector Switches applying +100 or — 100 volt reference to patch panel termination. Also provided are two comparator switches.

COMPUTER CABINET

supplied with Basic Computer is of rugged aluminum construction. Pretapped holes provide for easy expansion. Grill type bottom and rear cover allow convective air circulation. Power panel on rear mounts AC line connector, slaving connector, and banana jack termination of ten interconnects, reference supplies, signal ground and control signals.

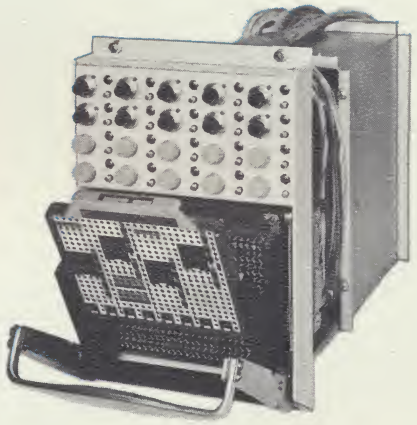


MULTIPLIER AND FIXED DIODE FUNCTION GENERATOR

cards plug into connectors at lower rear of patchbay assembly. Quad integrator networks and resistor network cards as supplied with amplifier expansion modules also plug into rear allowing all calibration adjustments to be made from back with components in place. Model D4.182 Repetitive Reset Units plug into quad integrator networks. Power distribution board is mounted on patchbay.

DIODE NETWORK CARD

Model D3.192.1 also plugs into rear of patchbay assembly providing diode and resistor networks for easy programming of typical non-linearities.



PATCHBAY ASSEMBLY

included with Basic Computer is completely prewired with connectors to accept full expansion complement. One 480 hole color coded removable patchboard and patchcord kit included.

20 COEFFICIENT POTENTIOMETERS

are also included. Ten turn, wire wound potentiometers with associated wiper arm fuses and readout pushbuttons are conveniently located just above patchboard. Expansion unit D10.2 replaces knobs on basic computer with two-speed calibrated, locking dials.

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FEATURES INSIDE ▶

The AD-2-24PB is a compact desk top general purpose analog computer designed to fit the needs of both professional and educational groups. The performance of the components equals or exceeds that of the largest computers available, yet it is compact and economical enough to serve as an individual scientist's tool. Also, its expansion capability and flexibility adapt it to the solution of a broad variety of problems.

EASE OF PROGRAMMING AND OPERATION

Completely internal input and feedback elements throughout include a 1.0 mfd and a 0.1 mfd capacitor plus 4 one megohm and 4 one tenth megohm resistors associated with each integrator for maximum flexibility in scaling.

Patchboard programming of repetitive operation for individual integrators allows simultaneous operation of real-time and repetitive integrators. Ten trunks are provided for external equipment connections or slave interconnect. Convenient monitoring of all computer components as well as a go, no-go check of amplifier balance allow highest confidence in solution. "Pot Set" and "Balance Check" mode provides for setting pots under correct load conditions and a check of operational amplifier balance without interference with patched problems. Complete protection from any damage by errors in patching allows the operator to concentrate on the problem to be solved rather than the computer.

ELECTRONIC REPETITIVE OPERATION SWITCHES

eliminate significant errors due to lack of coincidence of closing of mechanical mode control switching devices. This accurate switching plus precision reset to zero provides highest repeatibility of solution and accuracy in High Speed Repetitive and Iterative Operation.

HIGH ACCURACY

Accuracies consistent with the largest computers are available in the 24PB. Resistors are matched to better than $\pm 0.01\%$ to insure long-term stability to within $\pm 0.02\%$. Adjustable capacitors provide integration accuracy of .02%. The $\pm$ 100 volt range allows maximum accuracy of all non-linear equipment. Multipliers to $\pm 0.015\%$ (30 mv) of full scale, log X, X^2, sine and cosine function generators with varying accuracies are available. Variable diode function generators with completely arbitrary break points and up to 2 volts per volt slope on each segment permit representation of arbitrary functions.

RELIABILITY

The 24PB incorporates the same computing elements used in the larger 32 and 64 amplifier computers. These components have all been field proven by years of trouble free operation. Extensive use of etched circuit cards and highest quality, gold plated connectors increase the reliability. Components are all conservatively rated. The modular construction allows rapid signal tracing in addition to easy replacement or field expansion.

SLAVING

Two or more 24PB's can conveniently be slaved. Ten interconnect trunks terminate on each board. A slaving cable connects all ground, control and reference leads to allow all computers to be operated from any one. Thus a 48 or 72 amplifier computer facility can be obtained by slaving two or three 24PB's.

NON-LINEAR ELEMENTS

require no committed amplifiers. Both polarities of input variables to multipliers and diode function generators are patched directly to allow multiple use of such bipolar signals. Standard scaling of feedback elements for all non-linear components allows other variables to be summed or integrated with the same operational amplifier. This minimizes the number of amplifiers required for non-linear operations. Eleven, twenty-one and thirty-seven segment multipliers are available with only two adjustments on each.

UTERS

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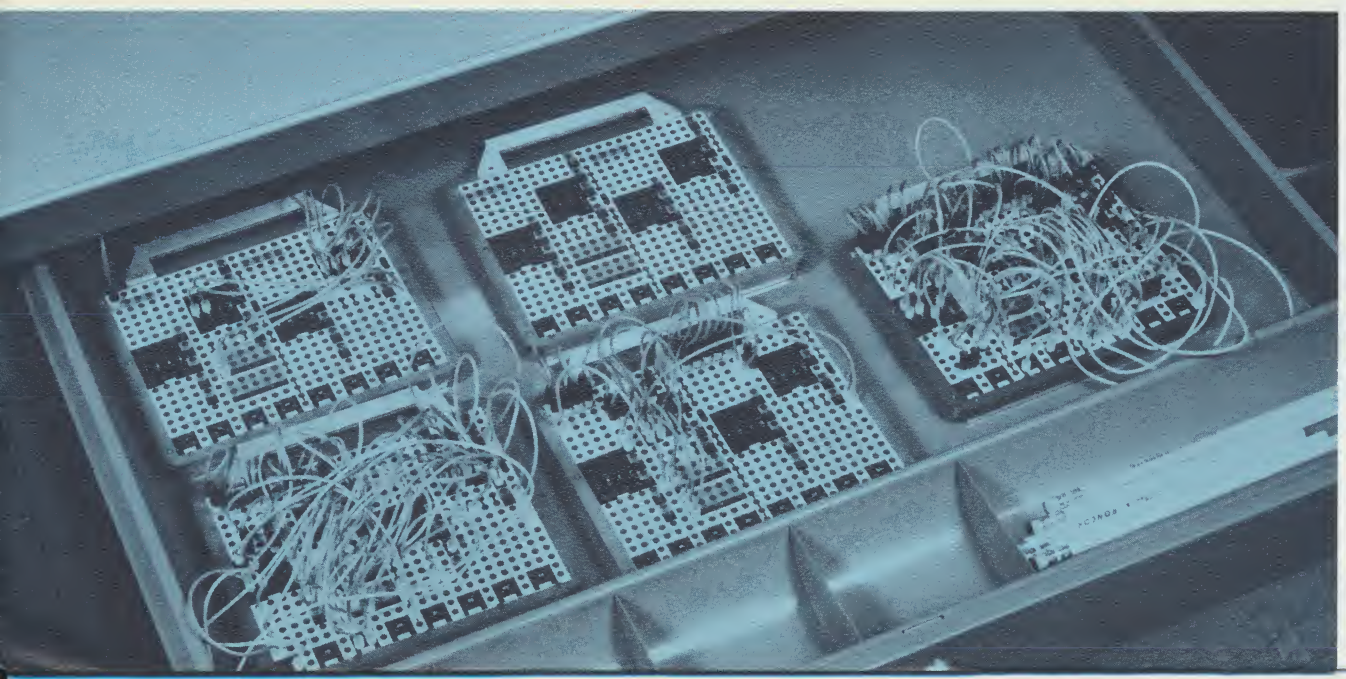
EXPANSION

	AD MODEL NUMBERS
The completely expanded AD-2-24PB includes:	
8 Combination Integrator-Summer Amplifiers 8 Summer-High-gain Amplifiers	two F12.13
8 Summer-Inverter Amplifiers	F12.14
20 Coefficient Potentiometers	included in basic unit
5 Non-Linear positions each of which can contain:	
Quarter Square Multipliers	E3.158, E3.164.2, E3.166.1, E3.168
Dual X^2 Diode Function Generators	E3.159, E3.165.2, E3.167.1, E3.169
Dual Log X Diode Function Generators	E3.172
Two 10 segment Variable Diode Function Generators	E3.171.1
Sine-Cosine Diode Function Generators	E3.173
2 Reference Selector Switches 2 Comparators with override switches	E4.2
Free networks, including	
5 Diode Resistor Networks	
2 Free Capacitors	
2 Zener Diode Limiters	D3.192.1
High Speed Repetitive Operation individually programed for each integrator.	E6.180.1 and four D4.182's

NOTE: All multipliers and fixed diode function generators are completely interchangeable.

INEXPENSIVE PROBLEM STORAGE

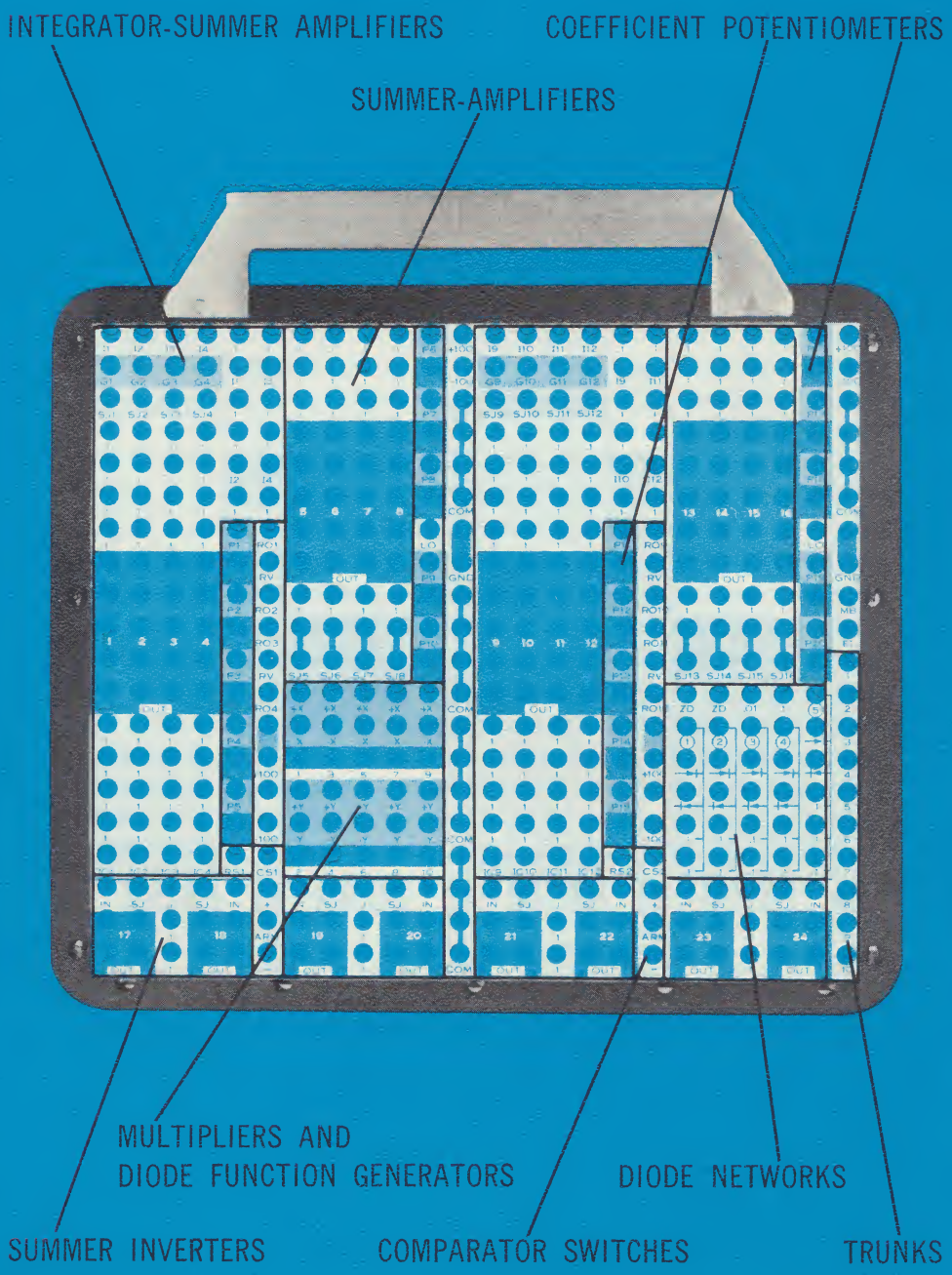
The 480 hole color coded removable problem boards and patch cords are priced to fit the budget that requires the storage of numerous problems or the availability of a number of boards such as in an educational lab. These small boards can be conveniently stored in a drawer. The boards and patchcords are ruggidized to withstand the most severe use. The color coding and labeling on the panel simplify patching and reduce patching mistakes. The snap lock patchcords avoid misconnection.



SIMPLIFIED PROGRAMMING

The color coded problem board of the 24PB is designed for simplified rapid programming. Symmetry of the layout and contrasting color coding allow rapid location of all computing components.

Clear lettering and small patch cords reduce patchboard clutter of wired programs. All computing elements are terminated behind the removable patchboard thereby eliminating the need for component duplication as more patchboards are used.



OPERATIONAL AMPLIFIERS

PERFORMANCE CHARACTERISTICS	UNSTABILIZED DUAL DC AMPLIFIER MODEL D1.111.2	WITH DUAL STABILIZER MODEL D1.122.1
Open Loop DC Gain	2×10^5	2×10^8
Grid Current	10^{-10} amps	10^{-10} amps
Drift Referred to Input	5mv/hour (average)	50 microvolts/day
Noise Referred to Input	1 millivolt RMS	1 millivolt RMS
Velocity Limit	2,000,000 volts/sec.	2,000,000 volts/sec.
Bandwidth (100k/100k)	–3db @ 100kc	–3db @ 100kc
Phase Shift @ 100 cps (100k/100k)	.05°	.05°
Voltage Range	±150V	±150V
Output Current	28 MA @ ±100v	28 MA @ ±100v

COMPONENT	MATCHED ACCURACY	NUMBER OF COMPONENTS PER AMPLIFIER 17-24	1-4, 9-12	5-8, 13-16	Spare Resistor Networks (4)
1 MFD Capacitor	±.02% (Adj)	—	1	—	—
.1 MFD Capacitor	±.02% (Adj)	—	1	—	—
100K Resistor	±.01%	—	4	3	2
1 Meg Resistor	±.01%	—	4	1	—
I.C. Resistor	±.01%	—	2 (100k)	—	—
I.C. Relays	±1 millisec.	—	1	—	—
Hold Relays	±1 millisec.	—	1	—	—
Patchboard Summing Junction	—	1	1	2	1
Patchboard Outputs	—	4	5	5	—

COMPONENTS

FEATURE	POTS
Total # Pots, , (# ungrounded)	20 (2)
Wire-wound, 10-turn, 50,000 ohms	yes
Type of Dial	#2606 Duodial (optional)
Number of switches to ± Ref.	2
Fuses available at Dial	yes

PATCHING SYSTEM

Patch Panel	Patch Cords
480 Holes on 0.25″ Centers	105 per 24 amplifiers
Six Colors	Color-coded by length
Removable from gold-plated Patch Bay connectors	Two pin plugs for adjacent holes
	Three lead squids for Rep. Op.

POWER SUPPLY MODEL E8.106

Input Power - 7 amps, 115 volts, 60 cps
Output (for 24 Amplifiers, Reference & Control)
12.6v AC (Filament Power) — 40 amps.
+200v DC, —250v DC (3 mv RMS noise)
—500v DC (30 mv RMS noise)

CONTROL UNIT MODEL E6.102.1

Modes — Balance Check, (pot-set), Reset, Operate, Hold
Meter Ranges — 500, 100, 10
1 volt, +null, —null
Null Pot Linearity .05%
3½ digit dial

MODEL D3.192.1 DIODE NETWORK CARD

Component	#1	#2	#3	#4	#5
Diode	2	2	2	2	2
Zener Diode pair	1	1	—	—	—
0.1 MFD	—	—	1	—	—
.01 MFD	—	—	—	1	—
100k ohms	2	2	2	2	3
Summing Junction	1	1	1	1	1

COMPARATOR MODEL D4.184.1
3 DPDT Relays 4 Free Diodes

REPETITIVE OPERATION

REPETITIVE CONTROL MODEL E6.180.1

.01 MFD capacitors (1%)

Operate periods — 1.00, .500, .250, .100, .050, .025 seconds; stand-by.

May be triggered externally in Standby mode.

Patchboard program for selecting repetitive or real time integrator networks.

All electronic gates reste initial conditions to zero

Time marker periods — 1.00, .050, .020, .010, .005 seconds
Output Power — sufficient to

drive 12 Dual Reset Units Model D4.182

Real time integrator networks are prewired for Plug-in Dual Repetitive Reset Unit Model 182.

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